A New Method for Face Recognition Using Wavelet

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***Abstract*—Content-Based Image Retrieval (CBIR) allows to automatically extracting target images according to objective visual contents of the image itself. Representation of visual features and similarity match are important issues in CBIR. In this paper an attempt is made to review a wide range of methods used for face recognition comprehensively. This include PCA, LDA, ICA, SVM, Gabor wavelet tool for recognition .This review investigates all these methods with parameters that challenges face recognition like illumination, pose variation, facial expressions.**

***Index Terms*— CBIR, Wavelet, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA).**

I. INTRODUCTION

Content-Based Image Retrieval (CBIR) is the process of retrieving desired images from huge databases based on extracted features from the image themselves.[1] CBIR provide access of multimedia databases that deal with text, audio, video and image data, which could provide us with enormous amount of information. CBIR is a technique, which uses visual contents (features), to search images from large-scale image databases according to users' requests in the form of a query image. There are so many different algorithms for face recognition which have different human face recognition rate with different database sets and different variation of poses. Face recognition algorithms are basically principal component analysis (PCA), 2DPCA (2-Dimensional), Sub-pattern recognition algorithm, Linear Discriminant analysis (LDA), Independent component analysis (ICA), Line edge map (LEM), Radial basis function (RBF), Elastic bunch mark graph(EBGM). [4] There are various applications of the face recognition such as Human - Computer interface, matching of photographs in static manner; security based video surveillance, Biometric based security, Image and video processing, Attendance system etc. There are various challenges in face recognition. These are Automatically locate the face, Identify similar faces(twins), Recognize the face from a general view point under different illumination conditions, facial expressions, and aging effects, variation in poses, Cartoon faces.

II. LITERATURE REVIEW

Sukhija P. et. al (2016) proposed a genetic algorithm based approach for face recognition. The proposed algorithm recognizes an unknown image by comparing it with the known training images stored in the database and gives information regarding the person recognized [2] .Given G. H. et al. (2013) proposed new opportunity for the application of statistical methods driven by growing interest in biometric performance evaluation [3] .Aman R.Chadha et. al (2011) discussed a face recognition technique for local and global features using discrete cosine transform. DCT is applied to whole face for local features and global features such as nose, mouth, and eyes are also extracted [4]. Jayshree Ghorpade et. al (2011) Discussed the use of PCA and SOM in face . In this paper author combines both PCA and SOM. For dimensionality reduction of human face image and for feature extraction and also tries to enhance these techniques.[5] Kulkarni A. Bormane D. (2013) Tells about a face recognition algorithm based on principal component analysis that is already implemented [6].

III. FACE RECOGNITION TECHNIQUES

For recognizing the face there are many commercial systems and new algorithms have been developed and proposed. Most of the systems use the Principal Component Analysis (PCA) as a base technique to recognize the face. There are different face recognition algorithms example principal component analyses, 2-dimensional principal component analysis (2DPCA), independent component analysis (ICA), line edge map (LEM), radial basis function (RBF), Linear Discriminant Analysis (LDA), elastic bunch graph matching (EBGM). These are the different techniques that are used to recognize the faces, each of this method has own performance rate for recognition the face.

A. Principal Component Analysis (PCA)

The term "Eigen faces" basically belongs to the PCA that is face recognition approach. Generally, refers to the use of "Eigen faces". PCA is used to remove the information which is not useful and therefore reduce the dimension data and accurately decompose the dimensions of face into components of orthogonal principal that are called as "Eigen faces". The results of covariance matrix are decreased by calculating the S^TS matrix rather than SS^T same as the covariance matrix. Where S is the matrix that is containing all vectors of an image. This deduction is balanced by multiplication of images T with the images S with Eigen vectors of the S^TS matrix. At last, results into the Eigen faces, these are the basic vectors and works as the matrix of projection. [3] For the compression of image and for the recognition of face PCA is used. In case of data of high dimension, for the ruling pattern, this is the commonly used technique. Different concepts of mathematics,

like standard deviation, covariance, eigenvectors and Eigen values will be used in PCA so they are discussed first as these concepts provide grounding on which this PCA is based.

B. 2-Dimensional Principal Component Analysis

2 Dimensional principal component analyses method to recognise the face is the enhanced algorithm from PCA. Computational cost of PCA is more than computational cost of 2DPCA. To reduce the computational cost, 2 D principal component analyses (2DPCA) was proposed. As vectors, images are treated in PCA, but in 2 D PCA the form of matrix, images are treated. To analyse the 2 D principal component analyses and principal component analyses effectiveness, there Eigen values of face images were obtained and that produced Eigen values are compared. To show the comparison of the 2 D principal component analyses and principal component analyses, result displayed in graphical in terms to show the accuracy and effectiveness. 2 D principal component analyses is easy for implementation on a digital computer in any programming language. 2D principal component analyses algorithm, from results shows that more effective and accurate**.[7]**

C. Independent Component Analysis (ICA)

In PCA image, with the Gaussian filter distribution images element treated as random variables and to minimize the statistics of second order. For any non-Gaussian distribution, PCA basis vectors, largest variances would not correspond. But independent Component Analysis method of face recognition minimizes both dependencies of higher order and second-order dependencies in the input data and which the statistically independent data tries to find on the basis of that. Bartlett had given two architectures of face recognition that are, 1st architecture- independent statistically basis on images and 2nd architecture given – representation of factorial code. In earlier technique, to perform ICA, to reduce the dimensionality, PCA is used.[8]

D. Linear Discriminant Analysis (LDA)

Same as PCA, LDA approach is also based on principles of some statistical features. In space of facial features or can say vectors find the underlying vectors that is between the classes of individual would maximized the variance and then within the classes find the maximized variance and then within the classes find the minimum variance between the sample of that same person. If this algorithm's efficiency increased, then to recognize the human face images of individual unknown, then this algorithm between the individual face images, would be able to discriminate and minor changes in expression. This algorithm has a training set.[9]

E. Elastic Bunch Graph Matching (EBGM)

EBGM technique uses the concept of small blocks of numbers that are called Gabor filters, once the related small area of an image, to produce the numbers that are called jets, by multiplying and adding the small selected blocks with pixels, to accommodate minor variations these minor variations these selected blocks location can be adjusted. In fact that, the Gabor filters are used to remove the variability in images, due to variation in contrast and lightning against deformations and small shifts. They are robust at the same time. To increase the dimensions in the space of face features with representation of Gabor filters. New technique to enhance significantly with new technique for normalization in illumination, the discriminating the ability of Gabor filters. [10]

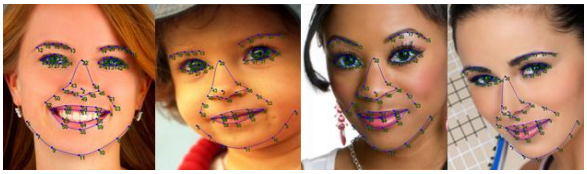

Fig.1. Elastic Bunch Graph Approach

F. Line Edge Map (LEM)

In its pre-processing phase, the technique makes use of hybrid LEM feature-based and template-based eye detection. The eye detection algorithm produces 100% result on the Caltech database [11], for a normalized error of 0.1.8 the face recognition technique is also implemented block-wise with face LEM and I-face LEM. Face recognition results of I-LEM and block-wise implementation show an improvement of 6-7%, and thus look promising.[11]

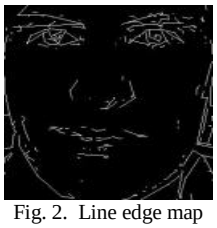

Fig. 2. Line edge map

G. Radial Basis Function (RBF)

To train the neural networks of RBF, an algorithm proposed that is hybrid learning algorithm. System's excellent performance achieves. Simulation result shows, both in terms of rate of occurring errors of learning efficiency and classification. From the information of gray scale, features vectors of face images are extracted. Most of face features extracted from spatial texture and gray scale information both. But to detect the face and recognition of face systems to use in real time are currently under construction. [11]

IV. ORL DATABASE

ORL database was actually given by OLLIVETTI RESEARCH LABORATORY. ORL database of contains the set of face images. These images were captured between 1992 and 1994 April at the lab of Cambridge University. In this data base, there are 400 images of faces. This data base is standard data base that is used in various types of face recognition study systems and used in various applications like vision, robotics and speech group of engineering department of university of Cambridge.

There are 10 different poses of one person. For some faces, images were captured at different times, with different poses or at different angles, different face expressions (eyes/closed eyes, smiling/ not smiling), with different style (glasses/ without glasses), changes in lighting conditions. All the images were captured against background that is homogenous dark with different position upright and frontal

position. Visibility of images of faces from data base is available.

All the images are in BMP format. Each face image has size pixels of 92 x 112with per pixel 256 gray levels and images are stored in folders. In 40 folders, images of 40 persons with 10 different poses are stored. Names of folders in sX form. In data base X indicates the numbers of folder starting from 0 to 9. S denotes the subject number that starts from 1 to 40. In these folders there are ten different poses of one person, which have names as Y.bmp, where Y is the image number between 1 and 10 for each person. Table-1 the following table shows description of images in ORL Database.

V. HAAR WAVELET

Wavelet decomposition using HAAR wavelet transforms that is used to compress an image and to extract the features from face image. To complete image, HAAR wavelet transform is applied. In these pixels, images are divided into N/2 x N/2 blocks. LL Sub band contains the maximum information of an image. In this work, LL sub band is used to extract the features. Let say, X be an input image matrix given below:

$$X = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

Then the HAAR wavelet transform (Y) of X is given by the below matrix transform:

$$Y = \frac{1}{\sqrt{2}} \begin{bmatrix} (a+b+c+d) & (a-b)+(c-d) \\ (a+b)-(c+d) & (a-b)-(c-d) \end{bmatrix}$$

These are the different operations performed correspond to sub-bands:

i. Top left : Low-Low Sub-band 2-D low pass filter.
ii. Top right : High-Low Sub-band horizontal high pass, vertical low pass filter.
iii. Lower left : Low-High Sub-band horizontal low pass, vertical high pass filter.
iv. Lower right : High-High Sub-band 2-D high pass filter.

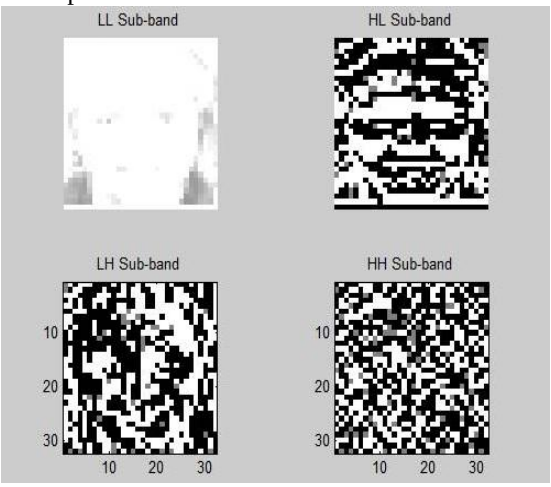

Fig.3. HAAR Wavelet decomposition of original image

The energies of all four sub images in Fig. 1 having values

Lo − Lo	Hi − Lo
88.2%	4.0%
Lo − Hi	Hi − Hi
6.3%	1.5%

As can be seen above, the maximum energy lies in the LL sub-band, therefore, LL sub band image is taken for face recognition purposes and taken for Euclidean distance vector generation.

VI. PROPOSED METHODOLOGY

These are the steps of this proposed work using HAAR Wavelet and correlation coefficient:-

1. Enter the group photograph as an input image, in which human faces must be present.
2. From the group photograph given as an input image, segment the individual faces using Viola Jones algorithm for further processing and select one image for recognizing the image
3. Using the wavelet transform decompose the detected face which have been selected for testing from the group photograph into sub bands and select the Low – Low sub band which contains the maximum frequency component of the face image.
4. The selected sub band is used to extract the features from the image. The image is now represented by feature vector which is one dimensional.
5. Load the ORL Database of human faces for processing.
6. Wavelet transform is used to obtain the four sub bands to test the face image on ORL database stored images and take the component containing the maximum frequency.
7. The maximum frequency component is used to extract the features from the face image. And then, reshape it for converting 2D matrix into feature vector which is one dimensional.
8. Correlation coefficient is calculated between test image and images of the stored database.
9. After calculating the correlation coefficient between the test image and stored database images, matching is performed based on the maximum value of correlation coefficient.
10. After matching the features, Ranking of different poses of similar face images is performed based on ascending order of value of correlation coefficient.
11. Display all the matched images.

ALGORITHM FOR FACE RECOGNITION USING EIGEN VALUES

Step1: Convert the acquired image into Grey scale image.
Step2: Compute the Eigen values.
Step3: Compute the mean of the acquired images.
Step4: Find out the difference of each image from the mean.
Step5: Form a covariance matrix and calculate its Eigen values and Eigen vectors.
No. of Images -->

EV	E1	E1	E1	T1
	E2	E2	E2	T2
	E3	E3	E3	T3
	E4	E4	E4	T4

Step6: Sort the Eigen values in descending order and choose the highest values.
Step7: Calculate the Eigen values using Eigen faces.
Step8: Find out projected train images using Eigen faces.
Step9: Take another image which is a test image and repeat the 1st step for this image.
Step10: Then project this image with the previous projected images and reshape them.
Step11: Find out the difference of the reshaped image from mean and then find out the projected test image with the help of difference image and Eigen faces.
Step12: Then find out the Euclidean distance between projected train images and projected test image.
Step13: Face recognition will be done on the bases of minimum Euclidean distance, minimum the Euclidean distance; image will be the best match.

VII. EXPERIMENTAL RESULTS

We have given a group image as input to face detection module. There are number of faces in group image. Then, using the viola-Jones algorithm, that faces are detected from group photograph. From that detected images, select one image for testing. We have used ORL database, there are 400 images of 40 persons with 10 distinct poses of one person. In this proposed work, we have taken 390 images that are stored in database for proceeding.

Fig.4. Group Photograph (Different faces are grouped in one image taken from ORL Database)

Fig.5. Single Faces are detected from group image

Fig.6. Test Image

We have selected one single image to give as query/test image. Then apply HAAR wavelet transform on that image and then that is converted into four sub-bands take LL-band that has maximum information. LL-sub band would be of 2-D that would be converted into reshaped into 1D format for find 1D-correlation to matching the features of face with stored database.

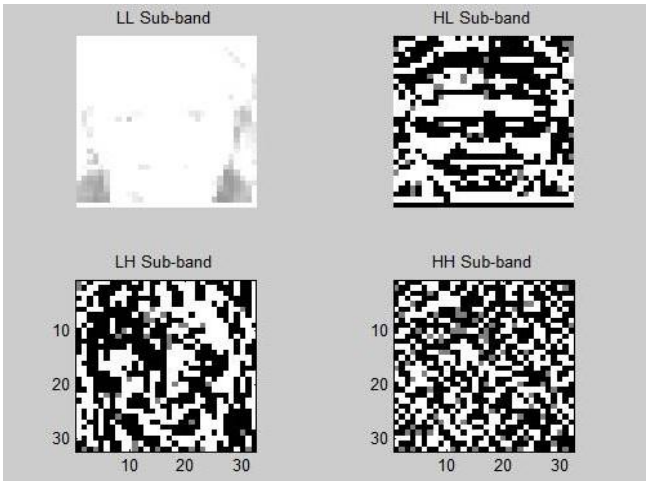

Fig.7. HAAR Wavelet Sub-Bands (LL, HL, LH, HH Sub-Bands)

Fig.8. Recognized Image at variation of pose

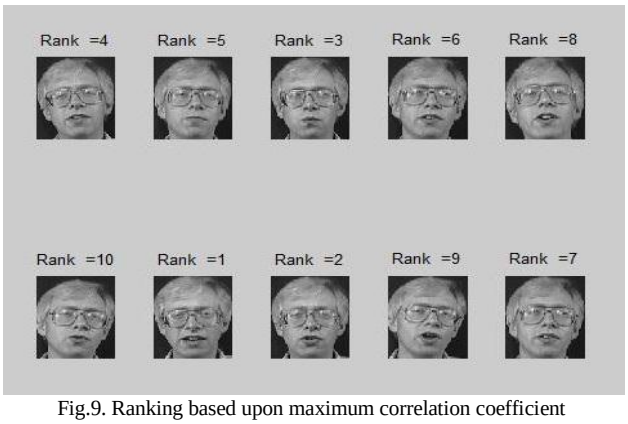

Fig.9. Ranking based upon maximum correlation coefficient

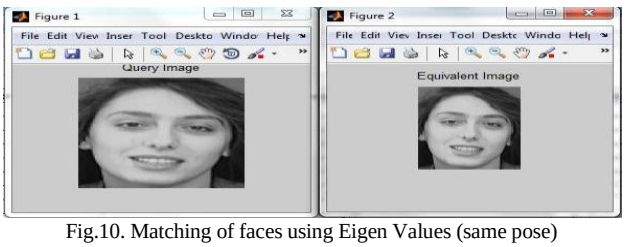

Fig.10. Matching of faces using Eigen Values (same pose)

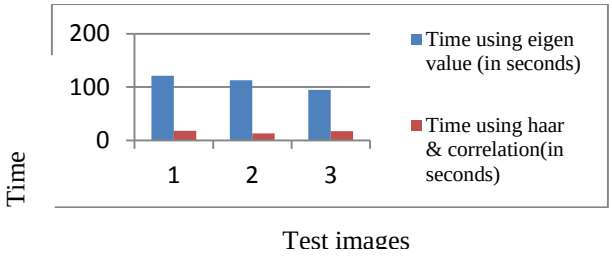

Fig.11. Graph shows the comparison between face using Eigen value and using HAAR Wavelet &1D correlation.

VIII. CONCLUSION AND FUTURE SCOPE

In Face recognition system, challenging to detect the face from group photograph & recognize the faces at different poses. In the proposed work, we have done the detection of human face from group photograph using Viola-Jones algorithm. From the detected faces, we have selected one face image from group photograph's detected faces as a test image. Using HAAR Wavelet and correlation coefficient, we have recognized the face at different poses. Matching of face features based on maximum correlation coefficient Index. Ranking of similar faces at different poses is done in this system. That is based upon ascending order of maximum correlation coefficient index and we have compared proposed system with face recognition using Eigen values. In proposed system, system is more accurate to recognize the face at different poses and speedy. Big difference came in time. Processing Time between Eigen value and proposed system is ~110 seconds and ~15 seconds respectively to recognize one face at a time. Face Recognition with Eigen values is less accurate to recognize the different pose as compared to proposed work.

Process to recognize the face is under construction. This proposed work can be applied to images of different type color format example RGB color format. This proposed work can be applied to real time images. This proposed approach can be used in biometric system. Attendance in schools, institutions and colleges can be taken using this system. This system is fast and accurate as compared to others.

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